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Microgravity Sciences on board ISS and beyond (6)

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MINIATURIZED FLUORESCENCE MICROSCOPE FOR BIOLOGICAL RESEARCH IN SPACE

Abstract

Understanding how the space environment affects biological systems has become important now that manned space exploration missions beyond the low Earth orbit are again in the roadmaps. The ISS is an ideal site to study the effects of gravity on biological systems, not only because of the microgravity environment, but also because it has research facilities where a 1g reference environment and partial gravity environments of Moon or Mars can be created with on-board centrifuges. A fluorescence microscope enabling in-situ research would be an advantageous instrument for research in this domain. Previously developed microscopes for space applications are bulky and cannot always provide different g levels.

Mini Fluorescence Microscope (MFM) is an ESA project with objectives to assess the feasibility of developing and manufacturing the smallest possible fully integrated fluorescence microscope to perform live cell imaging in space and to build a breadboard model of the microscope to test and verify the concept. The purpose was also to investigate potential platforms and science applications for MFM. The MFM is primarily designed for KUBIK, a platform on the ISS that contains a centrifuge. However, the possibility of further developing the microscope to other platforms was considered throughout the development.

The developed MFM breadboard model has dimensions of 82 mm x 42 mm x 31 mm. The design is based on a solid frame supporting subsystem modules, including optics, electronics, cell culture chamber and XY-table. The microscope has two fluorescence channels and a dark field imaging option. Applications for miniaturized fluorescence microscope in space research are diverse and include topics related to both humans and microorganisms. In addition to KUBIK, potential platforms for MFM are the ICE Cubes and Biolab facilities on-board the ISS, CubeSats and rovers. A microscope on a CubeSat platform would not be restricted to only microgravity research but could advance the understanding of synergistic effects of microgravity and space radiation. Microscope on a rover platform would be a powerful tool in primary rock analysis and in the search for extraterrestrial life.